

REMARKS

In the Action, claims 1-7 are rejected. In response, claim 4 is cancelled and claim 1 is amended. In view of these amendments and the following comments, reconsideration and allowance are requested.

Claims 1-7 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Claim 1 is amended to recite “a resultant reaction liquid” to provide proper antecedent basis throughout the claims. Claim 1 is also amended to include the subject matter of claim 4, which is now cancelled. As amended, claim 1 is submitted to be in proper form under 35 U.S.C. § 112, second paragraph, and allowable over the art of record.

Rejection Under 35 U.S.C. § 103(a)

Claims 1-7 are rejected as being obvious under 35 U.S.C. § 103(a) over U.S. Patent No. 6,414,182 to Shingai et al. Shingai et al. is cited for disclosing a reaction between a carboxylic acid and an alkylene oxide to produce a hydroxyalkyl ester. However, Shingai et al. does not disclose or suggest the step of distilling the resulting reaction liquid at a pressure of 1 to 40 hPa to recover the unreacted (meth)acrylic acid and thereafter recycling the recovered unreacted (meth)acrylic acid as a raw material for the reaction.

The present invention is directed to a process for producing a hydroxyalkyl (meth)acrylate where the unreacted (meth)acrylic acid is recovered by distillation. As noted in the Action, the reaction of a carboxylic acid and an alkylene oxide produces a hydroxyalkyl ester in a yield that is often less than 100%. However, as noted specifically on page 2, lines 14-18 of the present specification, (meth)acrylic acid has a strong affinity for the hydroxyalkyl (meth)acrylate and has a low relative volatility. Furthermore, the (meth)acrylic acid is easily polymerizable alone or in a mixed solution. As disclosed on page 11, lines 1-12

of the present specification, the prior processes for the separation, recovery and recycling of unreacted (meth)acrylic acid are difficult to carry out. Thus, the prior art processes have not been completely satisfactory in recovering and recycling unreacted (meth)acrylic acid.

The prior processes for the separation and recovery of unreacted alkylene oxide includes separation by stripping and by the use of absorbing solvents. See, for example, page 11, lines 1-5 of the specification.

The present invention recited in claim 1 is directed to the production process for producing a hydroxyalkyl (meth)acrylate and includes the step of distilling the resulting reaction liquid under a pressure of 1 to 40 hPa to recover the unreacted (meth)acrylic acid and thereafter recycling the recovered unreacted (meth)acrylic acid as a raw material. The art of record does not disclose or suggest the claimed process.

The Action refers to column 2, lines 30-40 of Shingai et al. as disclosing a distillation step for the removal of raw starting materials. This passage does not disclose distilling the reaction liquid as in the claimed invention. As disclosed in column 2, lines 36-39, the reaction liquid is led to a conventional step to remove the unreacted residues of raw material. The resulting liquid after the unreacted residues of raw materials have been removed, is then purified by distillation in a “subsequent final step” to obtain the hydroxyalkyl ester. Thus, this passage specifically discloses removing the unreacted components such as the (meth)acrylic acid prior to the distillation. There is no suggestion of distilling the reaction liquid to recover the unreacted (meth)acrylic acid in the distillation step. Furthermore, the examples of Shingai et al. also do not describe a method of removing the unreacted raw materials. Accordingly, Shingai et al. does not disclose or suggest removing unreacted raw materials from the resulting reaction liquid by distillation.

The Action also refers to column 3, lines 41-57 as disclosing recovering and recycling of unreacted alkylene oxide or carboxylic acid. This passage does not disclose distilling the resulting reaction liquid to recover the carboxylic acid. This passage is relevant only to the extent that it discloses recycling the unreacted reactants.

Column 12, lines 27-52 of Shingai et al. disclose generally recycling of unreacted materials to the reactor. This passage specifically discloses the step of separating a portion of the reaction liquid and recycling directly to the reactors as shown in Figure 5. The recycled portion is withdrawn directly from the outlet stream from the reactor as shown in Figure 5 and directed to the reactors 10 and 11 through lines 18 and 19, respectively. There is no disclosure or suggestion of separating or recovering the unreacted (meth)acrylic acid as in the claimed invention. Rather, a portion of the reaction liquid is simply recycled to the reactor. This passage also does not disclose or suggest distilling the resulting reaction liquid to recover the unreacted (meth)acrylic acid from the reaction liquid and then recycling the recovered (meth)acrylic acid as in the claimed invention.

The passage in column 12, lines 44-57 of Shingai et al. disclose purifying the crude hydroxyalkyl ester as a final step. However, this passage specifically discloses purifying the crude hydroxyalkyl ester after the above-noted recycling of a portion of the reaction liquid. There is no suggestion of distilling the reaction liquid to recover the (meth)acrylic acid and then recycling the (meth)acrylic acid to the reaction.

In view of the deficiencies of Shingai et al., claim 1 and the claims depending therefrom are not obvious to one of ordinary skill in the art. There is no suggestion in the art to distill the reaction liquid to recover unreacted (meth)acrylic acid and then recycling the recovered (meth)acrylic acid as in claim 1. Furthermore, Shingai et al. provides no motivation or incentive to one of ordinary skill in the art to modify the process of Shingai et

al. to include the claimed distillation and recycling step. The cited art provides no suggestion of distilling the reaction liquid at a pressure of 1 to 40 hPa to recover the (meth)acrylic acid as claimed. As disclosed on page 11, line 13 to page 12, line 2 of the specification, the operating pressure is important to the distillation, condensing and recovering of the (meth)acrylic acid. The importance of the operating pressure is evident from Comparative Example 1 and Comparative Example 2 of the specification. Comparative Example 1 forms a polymerized product which can cause clogging of the column while the distillation process is carried out as disclosed on page 11, line 18 to page 12, line 2. Comparative Example 2 results in an uncondensed vapor in the top of the condenser, thereby making it difficult to recover and condense the vapor as disclosed on page 11, lines 14-18. Accordingly, claim 1 is not obvious over Shingai et al.

Claim 2 depends from claim 1 to recite the step of recovering the unreacted alkylene oxide together with the unreacted (meth)acrylic acid in the distillation step, and thereafter recycling the alkylene oxide and unreacted (meth)acrylic acid. Claim 3 depends from claim 1 to recite the first step of separating unreacted alkylene oxide from the reaction liquid and thereafter recovering the unreacted (meth)acrylic acid by the distillation step. Shingai et al. does not disclose or suggest these process steps.

As note on page 11, lines 1-5 of the present specification, the conventional separation of alkylene oxide involves separating by stripping and recovering by absorbing solvents. Shingai et al. discloses only the conventional processes for recovering the unreacted reactants. Shingai et al. clearly fails to disclose or suggest recovering unreacted alkylene oxide together with the unreacted (meth)acrylic acid by distillation and then recycling the unreacted alkylene oxide and (meth)acrylic acid as in claim 2. Shingai et al. provides no

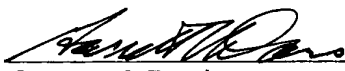
motivation or incentive to subject the reaction liquid to distillation to recover the alkylene oxide and (meth)acrylic acid simultaneously in the distillation step as presently claimed.

Shingai et al. further fails to disclose or suggest a first step of separating and recovering the unreacted alkylene oxide from the reaction liquid and thereafter distilling the reaction liquid to recover the unreacted (meth)acrylic acid. Accordingly, claim 3 is not obvious to one of ordinary skill in the art in view of Shingai et al.

Shingai et al. also fails to disclose distilling the reaction liquid with a plate column and/or packed column as in claim 5, distilling the reaction liquid in the presence of polymerization inhibitors, or distilling the reaction liquid where the reaction liquid has a (meth)acrylic acid concentration of 0.1 to 20 weight % as in claim 7. Shingai et al. discloses generally the use of conventional polymerization inhibitors during the reaction. There is no suggestion of distilling the resulting reaction liquid in the presence of polymerization inhibitors to recover unreacted (meth)acrylic acid). Accordingly, claims 5-7 are not obvious over Shingai et al.

In view of the above comments and these amendments, claims 1-3 and 5-7 are allowable over the art of record. Accordingly, reconsideration and allowance are requested.

Respectfully submitted,


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